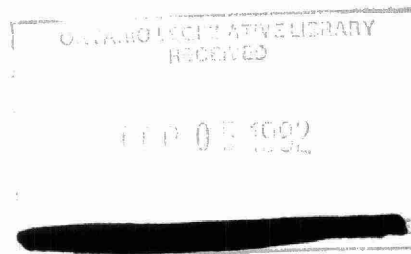


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AIR QUALITY INVESTIGATIONS  
in the vicinity of  
INCO METALS LIMITED, SHEBANDOWAN

1979-80

D. J. Racette  
Plant Pathologist

H. D. Griffin  
Chief, Air Quality Assessment

TECHNICAL SUPPORT SECTION  
NORTHWESTERN REGION  
ONTARIO MINISTRY OF THE ENVIRONMENT

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## INTRODUCTION

A snow sampling survey carried out in January, 1979, when mining and milling operations had been temporarily suspended, showed that concentrations of iron and nickel were elevated in snow in the vicinity of a 2500 ton-per-day base metal ore concentrator operated by Inco Metals Limited near Shebandowan, Ontario (1). The occurrence of metal contamination was ascribed to wind-blown particulate matter from a nearby storage pile of ore concentrate.

To obtain further information on levels of metals in air during a period when the mine was shut down, a moss exposure experiment was conducted in the same area during the summer of 1979. Soil samples were also collected to determine the levels of metals accumulated since 1973, when mining activities in the area began. Finally, another snow survey was conducted in early 1980 to obtain information on metal deposition during normal mill operating conditions.

## MOSS EXPOSURE EXPERIMENT

Mosses are effective substrates for absorbing and retaining some types of airborne contaminants. Techniques have been developed to suspend small quantities of moss in open-mesh bags to monitor the atmospheric environment (2). At Inco Metals Limited, samples of Sphagnum moss were exposed from May 8 to June 5, 1979, at 12 sites (Figure 1) plus two control locations remote from the survey area. Each sample comprised about 4 g (grams) of oven-dried moss contained in a 10 by 20 cm (centimetres) envelope of polypropylene screening attached to a plastic supporting bracket about 2.5 m (metres) above ground level. Samples, after exposure, were placed in polyethylene bags for refrigerated storage (4°C) until processed at the Ministry's Thunder Bay laboratory. Each sample was dried for 30 to 40 hours at 80°C, then ground in a "Wiley" mill equipped with a 1-mm (millimetre) pore-size screen.

A 1 g portion of each sample was reduced to ash at high temperature. The ash was digested in mixed acids, and the extract obtained was analysed by atomic absorption spectrophotometry for cobalt, copper, iron, and nickel.

Moss analysis results, in Table 1, show that slightly elevated levels of cobalt, copper, and nickel were present in the study area during the period of the survey. The difference between background levels and concentrations near the source was greatest for nickel, followed by copper and cobalt. The distribution pattern for nickel (Figure 2) was typical of those for the other two metals. All contaminant concentrations declined as distance from the concentrate stock piles increased.

#### SOIL SAMPLING SURVEY

On June 5, 1979, samples were collected with a stainless steel corer, 2 cm in inside diameter, from two depths (0-5 and 5-10 cm) of undisturbed soil at 12 stations in the study area (Figure 1) and at two distant control sites. Surface debris and loose organic matter were removed from the ground surface before each insertion of the corer. At least 10 cores of soil were pooled to form one sample. Triplicate samples were obtained from each site and were placed in polyethylene bags for storage, pending analysis. At the Ministry's Thunder Bay laboratory, the collected material was spread on paper and air dried for 48 hours, screened through a coarse sieve to remove stones and plant material, then passed through a fine, 40-mesh sieve. Dried, sieved soil was digested in mixed acids, then analysed for metal content as prescribed for moss. Soil pH was also determined.

Soil analysis results are presented in Table 2. Copper and nickel levels in surface soils were highest near the concentrator and concentrate piles (sites 1, 8 and 12). The distribution pattern for nickel, in Figure 3, was similar to that for copper and soil pH (expressed as hydrogen ion concentration), and showed that contaminant levels declined rapidly with increasing distance

from the ore concentrate stock piles. Normal levels of copper and nickel in surface soils were usually exceeded up to 300 m from the concentrator and concentrate stock pile area. Concentrations of cobalt and iron were not considered excessive. The occurrence of higher levels of cobalt, copper and nickel in surface than in subsurface soils indicated that airborne transport was the probable mechanism of contaminant dispersion.

### SNOW SAMPLING SURVEY

Duplicate samples of snow were collected on February 20, 1980, from 12 sites near the Shebandowan mining complex (Figure 1) and from two locations remote from the area. Sample collecting and processing procedures were similar to those used for the previous survey (1). Snow meltwater samples were analyzed for cobalt, copper, iron, nickel, zinc, and pH at the Ministry's Thunder Bay laboratory.

Snow meltwater results are summarized in Table 3. Concentrations of copper, iron, and nickel increased significantly over levels found in 1979, when mining and milling operations were temporarily suspended. Small increases were also recorded for cobalt and zinc. The distribution pattern for nickel, in Figure 4, was similar to that for cobalt, copper, iron, and zinc, and showed that contaminant levels declined with increasing distance from the concentrate storage piles and the concentrator buildings. Compared with normal background values for snow, the levels of copper, iron, and nickel near the centre of the study area were very high, while cobalt and zinc were only slightly elevated.

In contrast to 1979, light to heavy deposits of visible particulate matter, black in colour, were noted on or below the snow surface at sites 8 and 12. Sample core depth averaged 53 cm and ranged from 46 to 65 cm.

## CONCLUSIONS AND RECOMMENDATIONS

Investigations described in this report provide evidence of elevated concentrations of cobalt, copper, and nickel in the vicinity of Inco's Shebandowan operation. Copper and nickel were most significantly elevated, with cobalt slightly to moderately above normal. The general similarity between average ratios of nickel:copper:cobalt in soil (5:4:1), snow (8:6:1), and moss (11:11:1) suggested a common source of contamination. Distribution patterns of copper and nickel around the concentrator and concentrate stock piles indicated that these sites were principal sources of local contamination. Data from snow sampling surveys showed that metal deposition was much higher when the mine was operating than when it was shut down. Compared with levels at Sunshine rail siding, where Shebandowan ore is loaded on rail cars, concentrations of metals in soil were lower, while levels in snow were about the same. Although the metal concentrations in snow in the vicinity of the concentrator would produce melt-water toxic to aquatic life and unsuitable for drinking water supplies, it is likely that dilution during snowmelt rapidly reduces concentrations to acceptable levels. A water quality survey is planned to assess metal concentrations in local streams during spring snowmelt and at other seasons.

Soil in the study area contained levels of copper and nickel which approached concentrations that could have adverse effects on vegetation. Stunted growth and inhibited germination have been reported for vegetation grown in contaminated soil from the Sunshine rail siding (3) and in soil collected near a base metal mine in northeastern Ontario (4). At pH levels found in Shebandowan soils (pH 4.5-6.0), metals are usually fairly soluble and the possibility of harmful effects to plant life exists. Bioassay testing of these soils would be required to show these effects. Should reduced growth or other effects be demonstrated, these would be restricted to a very localized area near the mill.

The slightly elevated levels of copper, nickel, and cobalt in moss were attributed entirely to windblown particulate matter from the temporary concentrate stock pile. To determine levels of airborne metals during normal mill operations, we plan to repeat the moss exposure survey during the 1981 growing season.

Since there is no evidence of environmental damage off Inco's Shebandowan property, no abatement action is planned at this time.

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3. Racette, D. J. and H. D. Griffin. 1981. Phytotoxicology investigations in the vicinity of Sunshine rail siding, May-August, 1979. Ontario Ministry of the Environment.
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TABLE 1. Levels of cobalt, copper, iron and nickel ( $\mu\text{g/g}$ , dry weight) in moss exposed at Inco Metals Limited, Shebandowan from May 8 to June 5, 1979.

| Site               | Cobalt | Copper | Iron | Nickel |
|--------------------|--------|--------|------|--------|
| 1                  | 1      | 8      | 1700 | 10     |
| 2                  | <1     | 7      | 1800 | 4      |
| 3                  | <1     | 5      | 1900 | 3      |
| 4                  | <1     | 9      | 1900 | 10     |
| 5                  | <1     | 6      | 1700 | 6      |
| 6                  | <1     | 4      | 1500 | 7      |
| 7                  | 2      | 17     | 1400 | 38     |
| 8                  | 2      | 25     | 2000 | 42     |
| 9                  | 2      | 13     | 1400 | 20     |
| 10                 | 2      | 22     | 1900 | 35     |
| 11                 | 1      | 7      | 1800 | 7      |
| 12                 | <1     | 7      | 1600 | 5      |
| Exposed controls   | <1     | 4      | 1500 | 2      |
| Unexposed controls | <1     | 4      | 1900 | 4      |

TABLE 2. Levels of cobalt, copper, nickel ( $\mu\text{g/g}$ , dry weight), iron (%) and pH in two depths of soil (0-5, 5-10 cm) at Inco Metals Limited, Shebandowan, June 5, 1979.

| Site              | Cobalt |      | Copper |      | Iron |      | Nickel |      | pH  |      |
|-------------------|--------|------|--------|------|------|------|--------|------|-----|------|
|                   | 0-5    | 5-10 | 0-5    | 5-10 | 0-5  | 5-10 | 0-5    | 5-10 | 0-5 | 5-10 |
| 1                 | 12     | 6    | 150    | 15   | 2.1  | 1.8  | 210    | 33   | 4.8 | 4.6  |
| 2                 | 9      | 8    | 56     | 34   | 1.6  | 1.8  | 72     | 30   | 6.4 | 6.0  |
| 3                 | 6      | 7    | 17     | 18   | 1.6  | 1.6  | 24     | 20   | 6.1 | 6.0  |
| 4                 | 9      | 6    | 120    | 32   | 1.7  | 1.4  | 110    | 25   | 5.8 | 6.0  |
| 5                 | 10     | 9    | 42     | 11   | 2.3  | 2.3  | 58     | 25   | 5.8 | 5.6  |
| 6                 | 13     | 12   | 36     | 27   | 2.6  | 2.7  | 47     | 33   | 5.9 | 5.5  |
| 7                 | 11     | 11   | 120    | 31   | 2.1  | 3.3  | 180    | 43   | 5.4 | 5.1  |
| 8                 | 18     | 18   | 690    | 250  | 3.0  | 2.5  | 230    | 220  | 4.1 | 4.5  |
| 9                 | 17     | 10   | 200    | 37   | 2.0  | 2.1  | 290    | 53   | 5.5 | 5.6  |
| 10                | 10     | 6    | 83     | 20   | 2.0  | 1.6  | 111    | 24   | 5.9 | 6.6  |
| 11                | 10     | 10   | 41     | 29   | 2.2  | 2.4  | 52     | 31   | 5.7 | 5.6  |
| 12                | 22     | 11   | 330    | 44   | 2.5  | 2.5  | 440    | 68   | 5.1 | 5.0  |
| Control           | 15     | 16   | 39     | 36   | 2.3  | 3.2  | 29     | 32   | 5.7 | 5.6  |
| Normal background | <25    |      | < 100  |      | -    |      | < 100  |      |     |      |

TABLE 3. Levels of cobalt, copper, iron, nickel, zinc ( $\mu\text{g/l}$ ) and pH in snow samples collected January 16, 1979 and February 20, 1980.

| Site                              | Cobalt |      | Copper |       | Iron  |       | Nickel |       | Zinc |      | pH  |
|-----------------------------------|--------|------|--------|-------|-------|-------|--------|-------|------|------|-----|
|                                   | 1979   | 1980 | 1979   | 1980  | 1979  | 1980  | 1979   | 1980  | 1979 | 1980 |     |
| 1                                 | 1      | 44   | 40     | 1200  | 330   | 7400  | 36     | 1700  | 14   | 20   | 5.0 |
| 2                                 | <1     | 8    | 13     | 220   | 160   | 1400  | 10     | 250   | 3    | 8    | 4.8 |
| 3                                 | <1     | 2    | 2      | 170   | 110   | 780   | 1      | 110   | 3    | 6    | 4.5 |
| 4                                 | 2      | 24   | 11     | 700   | 250   | 4200  | 12     | 870   | 10   | 14   | 4.6 |
| 5                                 | <1     | 18   | 6      | 420   | 140   | 2700  | 6      | 620   | 3    | 14   | 4.6 |
| 6                                 | 2      | 10   | 20     | 270   | 430   | 1700  | 32     | 360   | 4    | 7    | 4.5 |
| 7                                 | 1      | 11   | 8      | 270   | 170   | 1700  | 8      | 360   | 4    | 6    | 4.6 |
| 8                                 | 14     | 55   | 42     | 12500 | 2300  | 72000 | 380    | 18000 | 24   | 68   | 6.0 |
| 9                                 | 6      | 44   | 83     | 1000  | 2600  | 6400  | 120    | 1600  | 12   | 12   | 4.8 |
| 10                                | <1     | 10   | 8      | 270   | 200   | 1900  | 10     | 350   | 3    | 8    | 4.6 |
| 11                                | 1      | 10   | 6      | 220   | 240   | 1600  | 10     | 330   | 3    | 14   | 4.6 |
| 12                                | -      | 14   | -      | 3000  | --    | 19000 | --     | 4500  | -    | 21   | 5.4 |
| Controls                          | 1      | <1   | 8      | 27    | 270   | 220   | 11     | 14    | 5    | 10   | 4.7 |
| Normal background                 | <50    |      | <100   |       | <1000 |       | <1000  |       | <50  |      |     |
| Drinking water objective          |        |      | 1000   |       | 300   |       | ---    |       | 5000 |      |     |
| Aquatic life protection objective |        |      | 5      |       | 300   |       | 25000  |       | 30   |      |     |

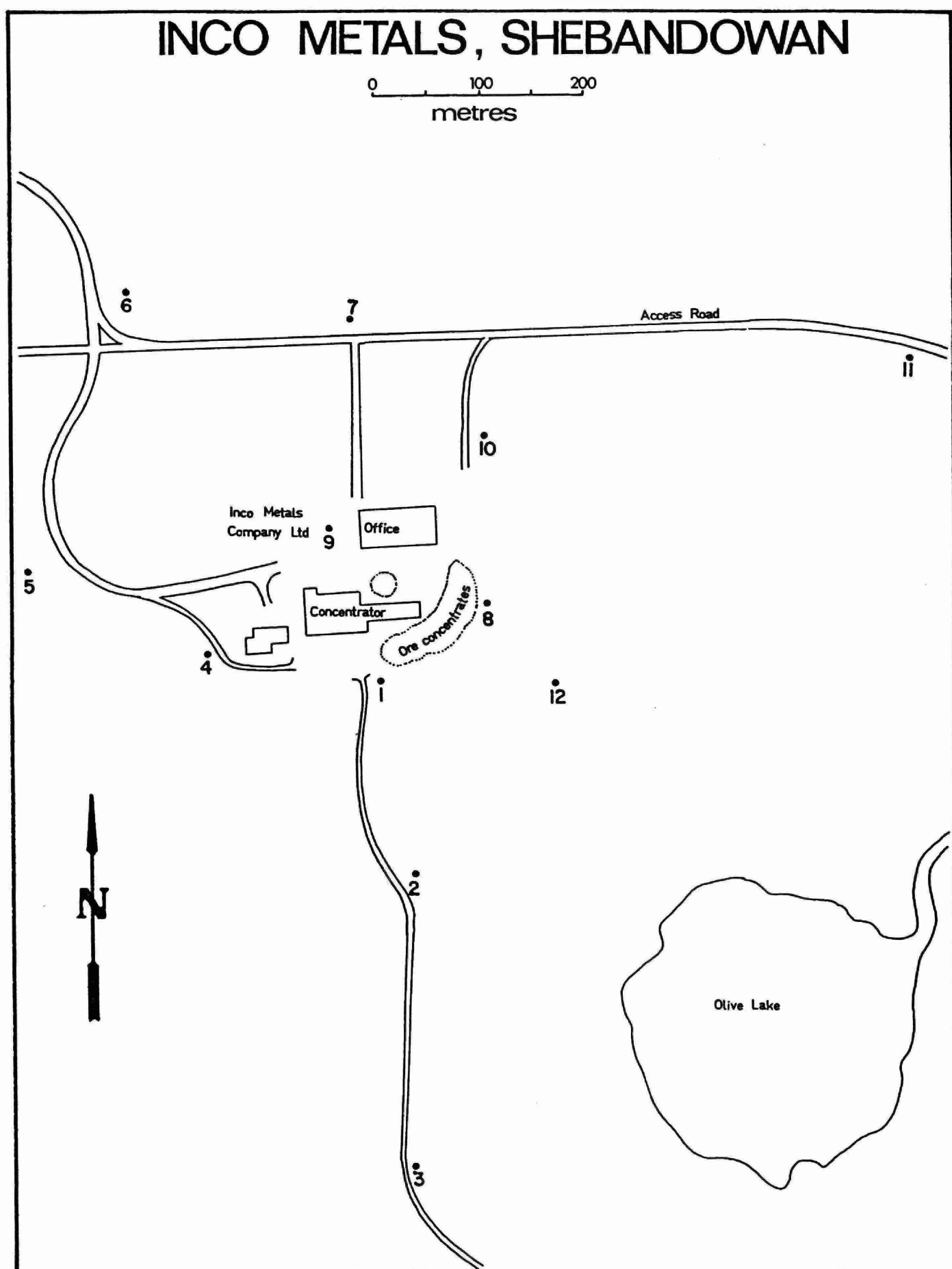


Figure 1. Moss bag exposure, soil and snow sampling sites, 1979-80.

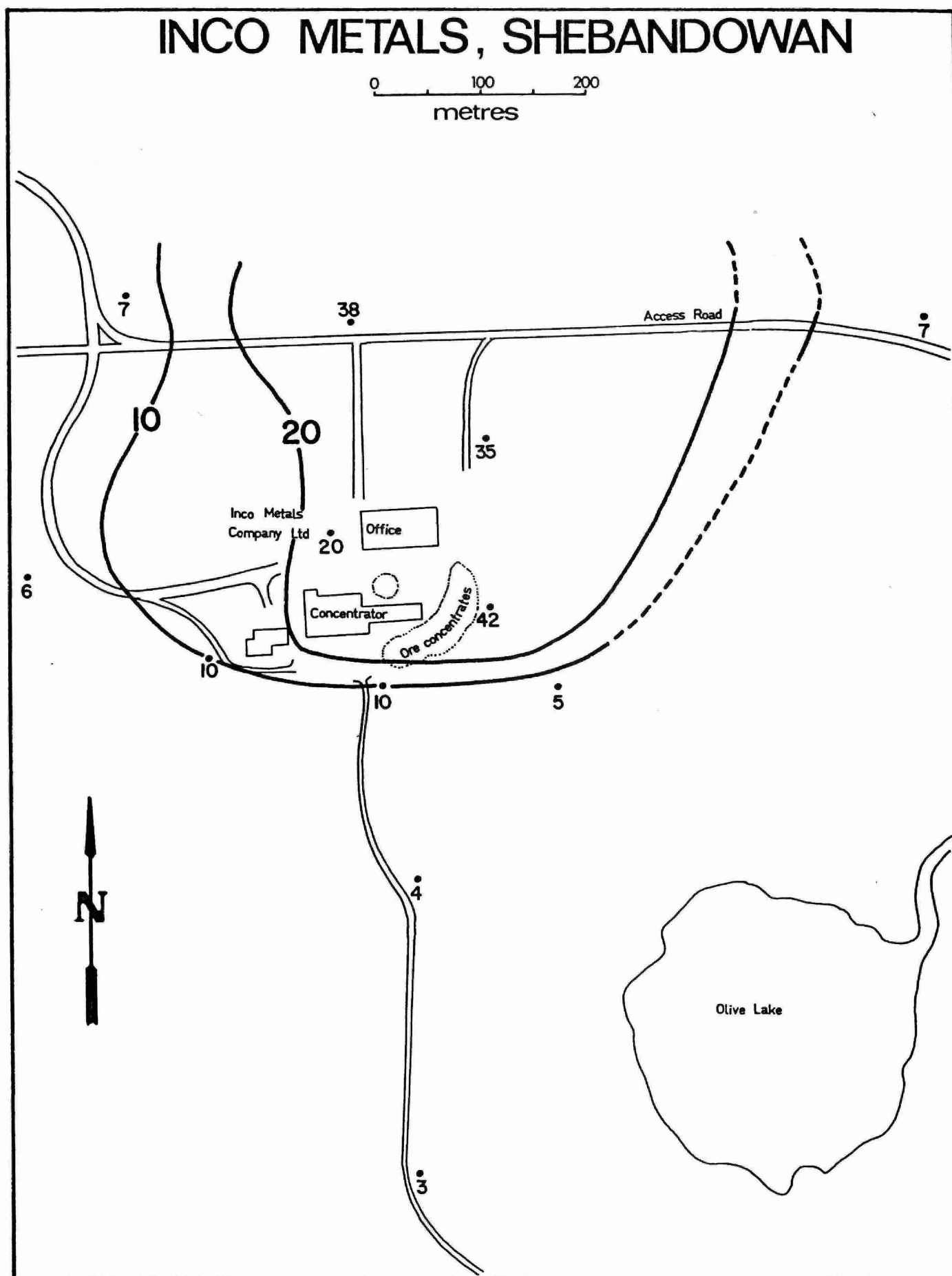


Figure 2. Levels of nickel ( $\mu\text{g/g}$ , dry weight) in moss exposed May 8 to June 5, 1979.

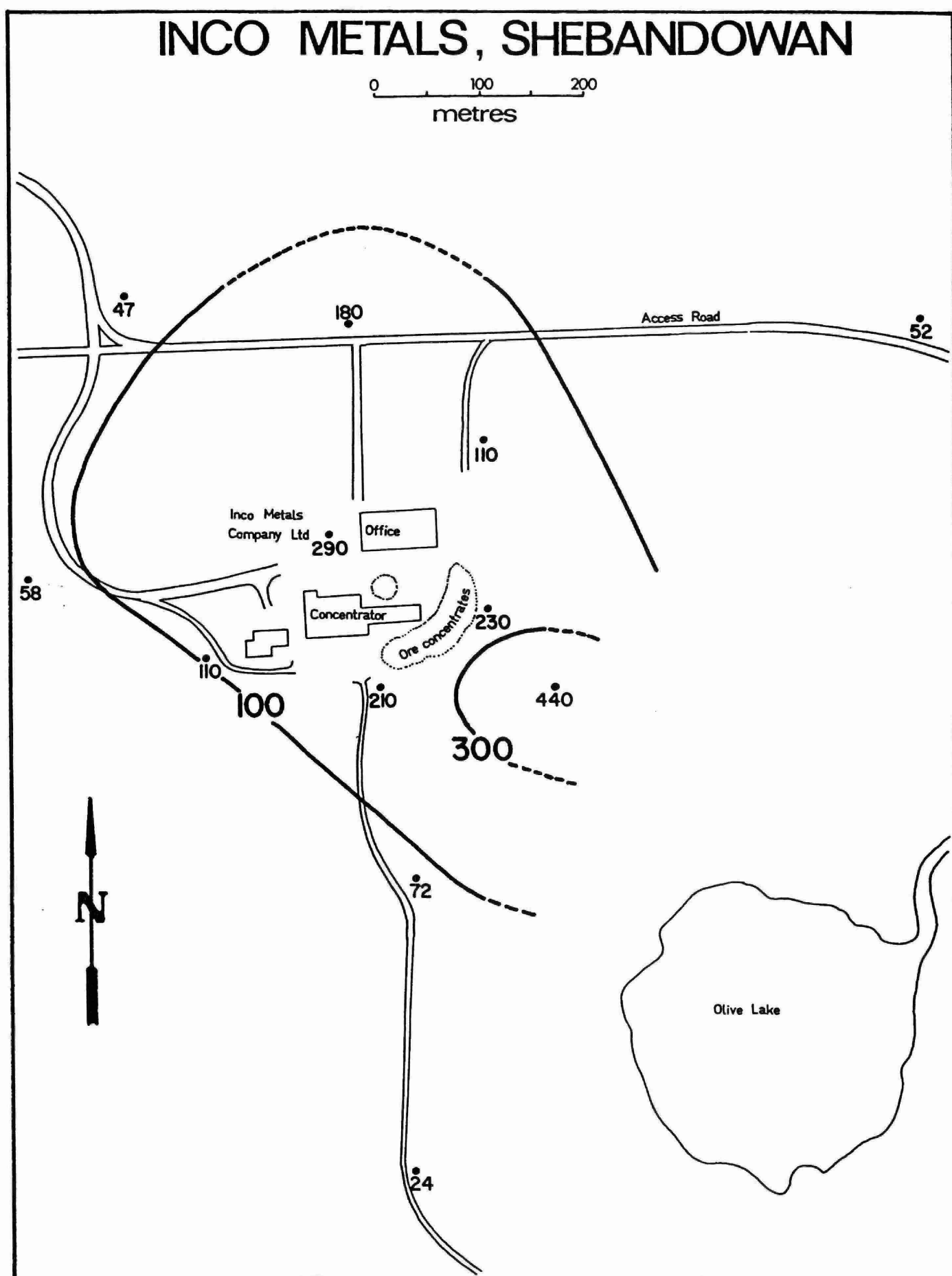


Figure 3. Levels of nickel ( $\mu\text{g/g}$ , dry weight) in soil (0-5 cm), June, 1979.

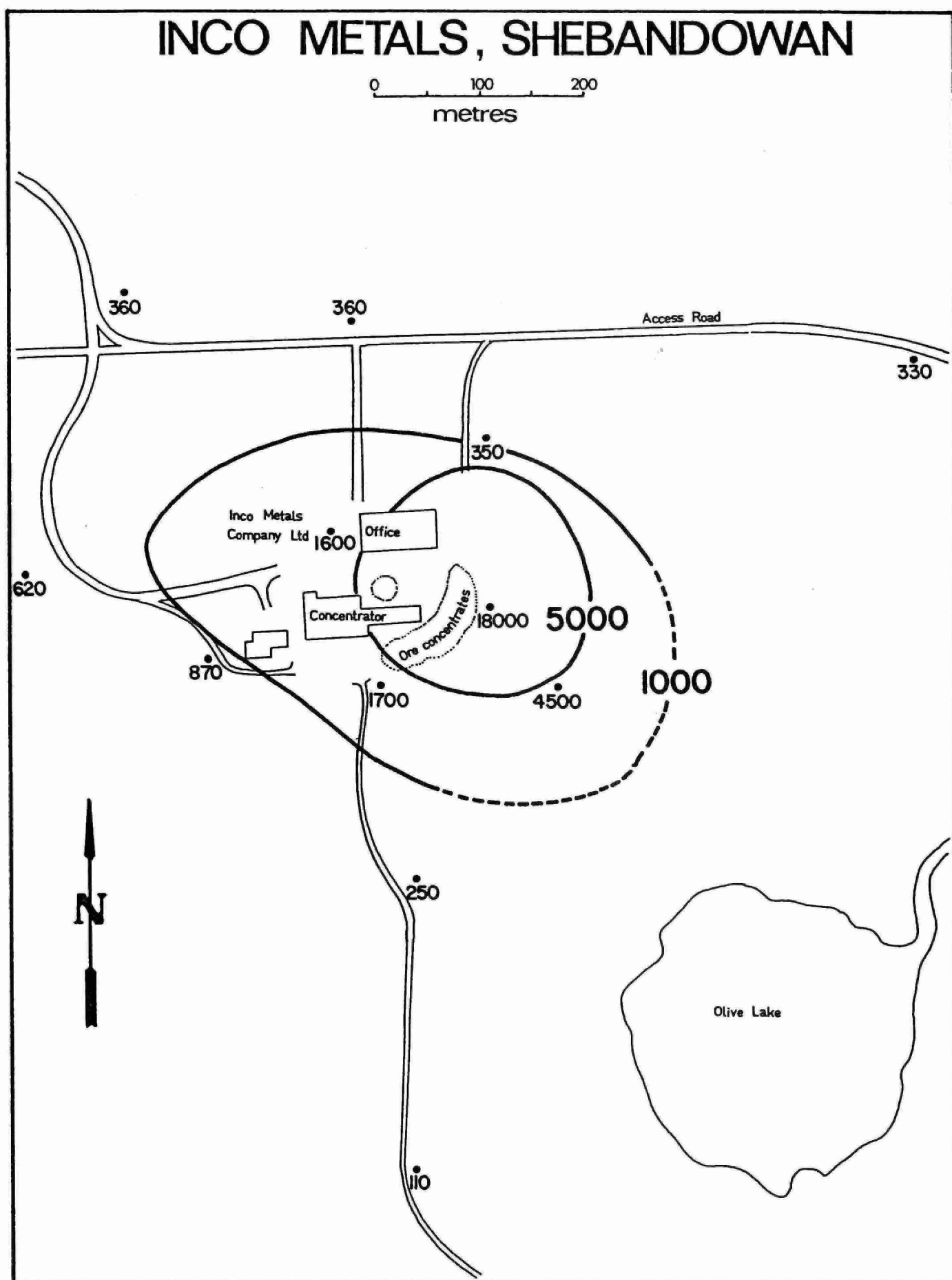


Figure 4. Levels of nickel ( $\mu\text{g/l}$ ) in snow, February, 1980.

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\*96936000009381\*